

PATENT COOPERATION TREATY

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

SENMYO, Kenji
Torimoto Kogyo Building
38, Kanda-Higashimatsushitacho
Chiyoda-ku, Tokyo 101-0042
JAPON

Date of mailing (day/month/year) 05 April 2001 (05.04.01)		IMPORTANT NOTICE	
Applicant's or agent's file reference AB-230			
International application No. PCT/JP00/06518	International filing date (day/month/year) 22 September 2000 (22.09.00)	Priority date (day/month/year) 27 September 1999 (27.09.99)	
Applicant ASAHI GLASS COMPANY, LIMITED et al			

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
CZ,EP,MX

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 05 April 2001 (05.04.01) under No. WO 01/23310

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 740.14.35</p>	<p>Authorized officer J. Zahra</p> <p>Telephone No. (41-22) 338.83.38</p>
---	--

PATENT COOPERATION TREATY

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

From the INTERNATIONAL BUREAU

To:

SEMYO, Kenji
Torimoto Kogyo Building
38, Kanda-Higashimatsushitacho
Chiyoda-ku, Tokyo 101-0042
JAPON

Date of mailing (day/month/year) 21 December 2000 (21.12.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference AB-230	
International application No. PCT/JP00/06518	International filing date (day/month/year) 22 September 2000 (22.09.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 27 September 1999 (27.09.99)
Applicant ASAHI GLASS COMPANY, LIMITED et al	

- The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
- This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
- An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
- The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
27 Sept 1999 (27.09.99)	11/272805	JP	15 Nove 2000 (15.11.00)

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 740.14.35</p>	<p>Authorized officer Somsak Thiphrakesone</p> <p>Telephone No. (41-22) 338.83.38</p>
---	---

PATENT COOPERATION TREATY

WO 01/23310
PCT/JP00/06518

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:
SENMYO, Kenji
Torimoto Kogyo Building
38, Kanda-Higashimatsushitacho
Chiyoda-ku, Tokyo 101-0042
JAPON

Date of mailing (day/month/year) 05 April 2001 (05.04.01)		
Applicant's or agent's file reference AB-230		IMPORTANT NOTICE
International application No. PCT/JP00/06518	International filing date (day/month/year) 22 September 2000 (22.09.00)	Priority date (day/month/year) 27 September 1999 (27.09.99)
Applicant ASahi GLASS COMPANY, LIMITED et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
 KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
 CZ,EP,MX

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 05 April 2001 (05.04.01) under No. WO 01/23310

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer J. Zahra Telephone No. (41-22) 338.83.38
--	---

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 00/06518

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C03B29/08 C03B23/023 C03B23/025

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 443 948 A (SAINT-GOBAIN VITRAGE INTERNATIONAL) 28 August 1991 (1991-08-28) the whole document ---	1-10
X	EP 0 928 779 A (ASAHI GLASS COMPANY LTD.) 14 July 1999 (1999-07-14) the whole document ---	1-10
X	EP 0 659 697 A (PILKINGTON GLASS LIMITED) 28 June 1995 (1995-06-28) the whole document ---	1-10
X	EP 0 592 862 A (TAMGLASS ENGINEERING OY) 20 April 1994 (1994-04-20) the whole document --- -/--	1-10

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

4 January 2001

Date of mailing of the international search report

10/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Van den Bossche, W

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 00/06518

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 486 952 A (TAMGLASS OY) 27 May 1992 (1992-05-27) the whole document ---	1-10
X	EP 0 443 947 A (SAINT-GOBAIN VITRAGE INTERNATIONAL) 28 August 1991 (1991-08-28) the whole document ---	1-10
X	EP 0 058 529 A (MCMASTER) 25 August 1982 (1982-08-25) the whole document ---	1-10
X	DE 21 58 812 A (SAINT-GOBAIN) 15 June 1972 (1972-06-15) the whole document -----	1-10

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
5 April 2001 (05.04.2001)

PCT

(10) International Publication Number
WO 01/23310 A1

(51) International Patent Classification⁷: C03B 29/08,
23/023, 23/025

(21) International Application Number: PCT/JP00/06518

(22) International Filing Date:
22 September 2000 (22.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/272805 27 September 1999 (27.09.1999) JP

(71) Applicant (for all designated States except US): ASAHI
GLASS COMPANY, LIMITED [JP/JP]; 12-1, Yuraku-
cho 1-chome, Chiyoda-ku, Tokyo 100-8405 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): YAMAKAWA, Hi-
roshi [JP/JP]; c/o Asahi Glass Company, Limited, 426-1,
Azakosawauehara, Sumida, Aikawa-machi, Aiko-gun,
Kanagawa 243-0301 (JP). TANAKA, Junji [JP/JP]; c/o

Asahi Glass Company, Limited, 426-1, Azakosawauehara,
Sumida, Aikawa-machi, Aiko-gun, Kanagawa 243-0301
(JP). YAJIMA, Toshimi [JP/JP]; c/o Asahi Glass Com-
pany, Limited, 1, Aza-asahi, Taketoyo-cho, Chita-gun,
Aichi 470-2514 (JP). TSUCHIYA, Masahiro [JP/JP];
c/o Asahi Glass Company, Limited, 1, Aza-asahi, Take-
toyo-cho, Chita-gun, Aichi 470-2514 (JP). KONISHI,
Masaaki [JP/JP]; c/o Asahi Glass Company, Limited,
1150, Hazawa-cho, Kanagawa-ku, Yokohama-shi, Kana-
gawa 221-8755 (JP).

(74) Agents: SENMYO, Kenji et al.; Torimoto Kogyo Build-
ing, 38, Kanda-Higashimatsushitacho, Chiyoda-ku, Tokyo
101-0042 (JP).

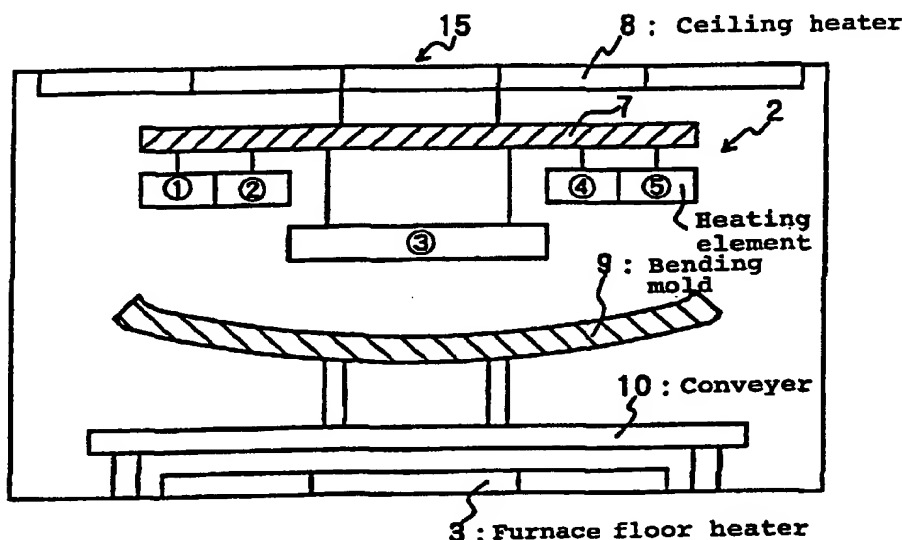
(81) Designated States (national): CZ, KR, MX, US.

(84) Designated States (regional): European patent (AT, BE,
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE).

Published:
— With international search report.

[Continued on next page]

(54) Title: BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING GLASS SHEET



(57) Abstract: A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace. A heating furnace (15) conveys a bending mold (9) of a glass sheet and a radiation-heating device is provided in the heating furnace, and a first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace (15), and a second group of a plurality of heating elements are disposed separately from an inner wall surface of the heating furnace.



WO 01/23310 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DESCRIPTIONBENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING
GLASS SHEETTECHNICAL FIELD

5 The present invention relates to a bending apparatus for at least one glass sheet to bend a glass sheet into a desired shape at a high accuracy and a method of bending at least one glass sheet.

BACKGROUND ART

10 When bend-forming a window glass for an automobile, at least one glass sheet cut into a predetermined size and shape is placed on a ring-like bending mold, and is stayed in a plurality of heating sections for a predetermined time in a bending zone of a heating
15 furnace, and is conveyed into the next heating section in order, and is heated to a bending temperature (usually about 550 to 650°C) of at least one glass sheet. Thus, the glass sheet is bended in accordance with the shape of the bending mold by self-weight.

20 In such a bending process of at least one glass sheet, it is necessary for obtaining a desired shape to accurately control a temperature distribution of the glass sheet at a high reproducibility. When at least one glass sheet is bended under a uniform temperature
25 condition by placing on a ring-like bending mold, it is known that the central part of the glass sheet between frame parts at both ends of the bending mold sags and the

sectional shape of the central line of the glass sheet becomes a flat pan bottom shape at the sagged part, or becomes a shape, the central part of which is somewhat lifted. In order to make a shape of aimed design, it is
5 necessary to maintain the peripheral zone of the glass sheet at a low temperature and the central part of the glass sheet at a high temperature, thereby forming a trapezoidal temperature distribution.

In a bending process of a glass sheet, it is known
10 to form a temperature distribution on a glass sheet. For example, it is known to employ a method of placing a locally heating device faced to the side portions of a glass sheet in order to locally largely bend the side portions of the glass sheet. However, to locally heat
15 the side portions of a glass sheet is a technical idea different from locally heating the central portion other than deformed portions in order to prevent deformation of the peripheral portion of the glass sheet.

On the other hand, there is known a glass molding
20 apparatus provided with a heat-shielding plate to shield a bending mold for placing at least one glass sheet from heat in order to obtain such a temperature distribution as to make the temperature of the central part higher than the temperature on both ends of the glass sheet as
25 mentioned above.

DISCLOSURE OF THE INVENTION

However, this conventional molding apparatus

provided with a heat-shielding plate is so complicated in respect of its structure as to disturb automatic conveyance of at least one glass sheet. Further, since the heat-shielding plate is fixed to a bending mold, a
5 tensile stress is produced during cooling step in a zone of at least one glass sheet-placed portion of right above the heat-shielding plate, thereby lowering a strength of the glass sheet. Also, since the heat-shielding plate has a heat capacity which becomes a load to heating, it
10 is hard to heat the whole within a furnace to such a high temperature as to be required for bending because heating energy is not efficiently used. As this result, a time required for bending is increased, and productivity is lowered.

15 In order to solve such a problem, JP-A-7-277754 proposes a method for obtaining a desired temperature distribution by providing a shield at appropriate position and height between heating elements, thereby limiting a heating range of the heating elements.

20 However, this method requires many shields to be provided depending on shapes of individual products, and is therefore hardly widely usable. Also, it is necessary to move many shields up and down respectively independently depending on the shapes of products, and it
25 is therefore necessary to provide a plurality of elevating mechanisms which make the total structure very complicated. Also, in such a case, to provide shields

other than heating means makes an obstacle to raising the whole part within a furnace to a satisfactorily high temperature, and heating energy is not efficiently used, thus lowering heat efficiency.

5 The present invention has been made by taking the above conventional techniques into consideration, and an object of the present invention is to provide a bending apparatus of simple structure capable of efficiently forming at least one glass sheet into a desired shape at
10 a high accuracy by forming a satisfactory temperature distribution on the glass sheet without lowering heat efficiency within a furnace.

 In order to achieve the above object, the present invention provides a bending apparatus for bending at
15 least one glass sheet placed on a bending mold into a desired shape by heating in a furnace, which comprises a bending mold for placing at least one glass sheet thereon, a tunnel-like heating furnace through which the bending mold is conveyed, a first group of a plurality of
20 heating elements fixed on an inner wall of the heating furnace, and a radiation-heating device having a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

 Further, the present invention provides a method of
25 bending at least one glass sheet into a desired shape, which comprises placing at least one glass sheet on a bending mold, introducing the glass sheet placed on the

bending mold into a heating furnace having a tunnel-shaped inside, and heating the glass sheet by two types of heating means of a first group of a plurality of heating elements fixed on an inner wall surface of the heating furnace and a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

According to this structure, the whole part within the heating furnace can be maintained at a satisfactory heat-bending temperature by a first group of heating elements, and at least one glass sheet can be efficiently heated from a position closer to the glass sheet separated from the inner wall surface of the furnace by a second group of heating elements. Thus, by efficiently using each heating element, its heating energy can be used efficiently for bending the glass sheet without loss.

In this case, the first group of heating elements are fixed and supported at the ceiling side or floor side of the heating furnace by means of an appropriate mounting plate or supporting bracket or the like, and are thus firmly fixed on the inner wall surface of the furnace to provide a heating device. On the other hand, the second group of heating elements constitutes a separate heating device separated from the inner wall surface of the heating furnace.

A preferable structure example includes the second

group of heating elements which radiation-heat locally a predetermined position of at least one glass sheet to provide a predetermined temperature distribution on the glass sheet.

5 According to this structure, the whole part within a furnace is heated by the first group of heating elements, and at least one glass sheet is locally heated by means of the second group of heating elements placed at a position closer to the glass sheet than the first group
10 of heating elements to form a required satisfactory temperature distribution on the glass sheet. By this manner, at least one glass sheet can be locally heated by efficiently using heat energy to provide a desired temperature distribution on the glass sheet.

15 The second group of heating elements are composed of a plurality of heating elements, each of which can control its heating temperature, and the second group of heating elements can be placed close to at least one glass sheet in such a manner as to form a desired
20 temperature distribution on the glass sheet by radiation heat from each heating element (if the heating elements are placed too part from the glass sheet, the whole part of the glass sheet is uniformly heated and a satisfactory temperature distribution cannot be provided). By
25 selectively using each heating element of the second group of heating elements, a heating temperature can be controlled and a desired temperature distribution can be

provided on the glass sheet. Also, by using the second group of a plurality of divided heating elements, it is possible to adjust a temperature depending on a size of a glass sheet employed, thus enabling a wide applicability.

5 A further preferable structure example includes the second group of heating elements suspended from the ceiling inner wall of the heating furnace in such a manner as to be opposed to the upper surface of at least one glass sheet.

10 According to this structure, it is possible to place the second group of heating elements close to the glass sheet by means of a simple structure without changing the structure of a bending mold and without adversely affecting the structure or movement of the conveying
15 system.

Also, a further preferable structure example comprises the second group of heating elements placed at a variable distance from the inner wall surface of the heating furnace.

20 According to this structure, it is possible to vary a distance between at least one glass sheet and each heating element of the second group of heating elements. By this manner, it is possible to adjust a radiation-heat amount and to simply and accurately form a desired
25 temperature distribution on the glass sheet by varying a position to be locally heated and a heating temperature depending on a material or shape of the glass sheet.

Also, a further preferable structure comprises the second group of heating elements, each of which has a heater wire and an equally heating plate provided on the heating surface of the heater wire.

5 According to this structure, it is possible to accurately control a temperature by equally imparting radiation-heat from each heating element to at least one glass sheet. Thus, the heater wire constituting a heating element is not exposed to at least one glass
10 sheet but an equally heating plate is provided between the heater wire and the glass sheet. In this manner, a temperature is controlled by the surface temperature of the equally heating plate. By using the equally heating plate, an extreme local heating by the heater wire can be
15 avoided, and a desired temperature distribution can be formed on the glass sheet without damaging the glass sheet.

Also, by using such an equally heating plate, each heating element can provide a uniform temperature face,
20 and accordingly each heating element can be easily controlled by a computer and deformation analysis of at least one glass sheet can be easily made by means of finite element method, thus enabling to previously fix a temperature of each of individual heating elements.

25 As mentioned above, in order to achieve the above object, a radiation-heating device employed in the present invention comprises a first group of heating

elements fixed to an inner wall surface of a heating furnace and a second group of heating elements divided into each heating element in the vicinity of at least one glass sheet in the furnace, and a desired temperature distribution can be provided on at least one glass sheet by selectively employing each heating element or by adjusting its fixed temperature of each heating element. In such a case, the second group of heating elements for providing a temperature distribution are preferably individually divided and disposed along such a direction as to form a desired temperature distribution on at least one glass sheet. For example, when a heating device is prepared by arranging heating elements of longitudinal shape in a row and the heating device thus prepared is applied to preparation of a window glass for an automobile, heating elements are disposed so as to put the longitudinal direction of each heating element along the direction vertical to the center line of at least one glass sheet (width direction of a glass sheet) in the vicinity of the central part of the glass sheet. Also, in the central part of the side periphery, in order to control a bending depth of at least one glass sheet, the heating elements are disposed so as to put the longitudinal direction of each heating element in the direction parallel to the centerline of at least one glass sheet (see the following Figure 4).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a general structure view illustrating a bending apparatus for at least one glass sheet employed in the present invention.

5 Figure 2 is a structure view illustrating an example of a radiation-heating device used in the present invention.

Figure 3 is a structure view illustrating another example of a radiation-heating device used in the present
10 invention.

Figure 4 is a structure view illustrating still another example of a radiation-heating device used in the present invention.

Figure 5 is a sectional view illustrating an example
15 of a radiation-heating device used in the present invention.

Figure 6 is a sectional view illustrating another example of a radiation-heating device used in the present invention.

20 Figure 7 is a structure view of the inside of a furnace illustrating an example of a bending apparatus of the present invention.

Figure 8 is a structure view of the inside of a furnace illustrating another example of a bending
25 apparatus of the present invention.

Figure 9 is a sectional view illustrating a preferable structure of a heating element used in the

present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the embodiments of the present invention are explained with reference to the drawings.

5 Figure 1 is a general structure view illustrating a bending apparatus for at least one glass sheet concerning an embodiment of the present invention.

A tunnel-like heating furnace 1 comprises a preheating zone Z1, a bending zone Z2 and a annealing
10 zone Z3. Each zone comprises a plurality of sections (in this example, the preheating zone comprises 4 sections, the bending zone comprises 8 sections and the annealing zone comprises 4 sections). A conveyer (not shown) is provided through the preheating zone Z1, the bending zone
15 Z2 and the annealing zone Z3, and a bending mold (not shown) having at least one glass sheet placed thereon is conveyed through a heating furnace by the conveyer. In the bending zone Z2, a ceiling heater (not shown), a floor heater 3 and a side wall heater (not shown) are
20 provided respectively on the ceiling, floor and side wall of the heating furnace 1. Each of the ceiling heater, the floor heater and the side wall heater comprises a plurality of heating elements fixed on an inner wall surface of the heating furnace 1 by an appropriate fixing
25 and supporting means. These ceiling heater, floor heater and side wall heater heat the whole part within a furnace, and constitute a first group of heating elements

of the present invention.

A divided radiation-heating device 2 of the present invention is provided on the upper side of a conveyer (not shown) of each section of the bending zone Z2 in
5 such a manner as to be separated from the ceiling inner wall of the heating furnace. The radiation-heating device 2 constitutes a second group of heating elements of the present invention.

The bending mold comprises a ring having a shape
10 curved so as to almost corresponds to an aimed bending shape of the periphery of at least one glass sheet as the main constituting element.

After cutting a glass sheet into a predetermined shape, one or two or more glass sheet is placed on the
15 bending mold and heated to about 500°C in the preheating zone Z1. Thereafter, the glass sheet is heated so as to form a desired temperature distribution thereon in the bending zone Z2, and is bended into a shape in conformity with the shape of the bending mold by self-weight. The
20 glass sheet is then slowly cooled in the annealing zone Z3.

The bending mold having the glass sheet placed thereon is conveyed so as to intermittently stop at each section in the heating furnace 1. A desired temperature
25 distribution is formed on at least one glass sheet by the radiation-heating device (second group of heating elements) of the present invention while staying in a

section in order in the bending zone Z2 in the furnace.
The temperature distribution becomes an aimed temperature
distribution when the bending mold is stayed in the final
section of the bending zone Z2, and the glass sheet is
5 bended into a desired shape by self-weight.

Figure 2 is a structure view illustrating an example
of a radiation-heating device 2 (second group of heating
element) provided in the heating furnace of Figure 1.

A plurality of heating elements of longitudinal
10 shape (nine elements in this example) ① to ⑨ are
disposed in a row to form a radiation-heating device 2.
Each of the heating elements ① to ⑨ is disposed in the
left and right direction of the central part of the glass
sheet 4 or 5 of forming a window glass for an automobile
15 in such a manner as to put the longitudinal direction of
each element in the vertical direction (horizontal
direction) of the center line C of the glass sheet 4 or
5. By this manner, a temperature distribution is formed
depending on a radiation heat from each heating element
20 along the center line C of the glass sheet 4 or 5. The
radiation-heating device 2 is provided in the vicinity of
the upper side of the glass sheet in the bending zone Z2
of the heating furnace 1. The floor heater 3 is provided
on the lower side of the glass sheet. The floor heater 3
25 also comprises a plurality of divided heating elements in
the same manner as in the radiation-heating device 2
provided on the upper side of the glass sheet, and this

is preferable for forming a temperature distribution at a higher accuracy. In this case, a distance between the glass sheet and the radiation-heating device 2 is adjusted so as to be capable of forming an aimed
5 temperature distribution by each heating element, and is in the range of about 50 to 250 mm. A surface temperature of each heating element of the radiation-heating device 2 is controlled individually depending on each heating element in each section.

10 A bending mold having at least one glass sheet placed thereon can be accurately stayed at a predetermined position of each section in the furnace. The deepest position of the section of a glass sheet to be bended is determined by a position relationship
15 between a radiation-heating device 2 and a glass sheet 4 or 5. When a windshield glass of an automobile is designed so as to be smoothly connected with a roof part, the most deeply bended position of the section of the windshield glass is on the upper part (upper part of the
20 windshield glass mounted on a car body). In the case of such at least one glass sheet, a temperature distribution having a higher temperature at the upper part of the glass sheet can be easily formed by adjusting a position of stopping the bending mold having the glass sheet
25 placed thereon and a temperature of each heating element depending on disposition of the radiation-heating device 2 shown in Figure 2.

Figure 3 is a structure view illustrating another embodiment of a radiation-heating device 2 of the present invention.

This embodiment comprises a radiation-heating device
5 2 having five heating elements ① to ⑤ placed along the center line C in the central part of the inner side of a glass sheet 6.

Figure 4 is a structure view illustrating still another embodiment of a radiation-heating device of the
10 present invention.

This embodiment comprises two heating elements a and b and two heating elements c and d respectively provided on the left side and the right side of heating elements
15 ① to ⑨ in the central part in addition to the radiation-heating device illustrated in the above Figure 2 in order to form a temperature distribution on both side parts in the left and right direction (width (car width) direction of a window glass for an automobile) of a glass sheet 6.

Figure 5 is a sectional view illustrating an example
20 of a radiation-heating device 2.

In this example, each of heating elements ① to ⑨ is provided on a heater rack 7 in such a manner as to make the height of the lower side face (heat-radiating face) of each heating element constant. The heater rack 7 is
25 supported separably from the ceiling inner wall of a heating furnace.

Figure 6 is a sectional view illustrating an

embodiment wherein the disposition of each of the heating elements ① to ⑨ of the radiation-heating device 2 shown in Figure 5 is changed.

In this example, a height of each of heating
5 elements ① to ⑨ on the heater rack 7 is made variable,
and each height of each heating element is variable as
compared with the embodiment illustrated in Figure 5. By
adjusting the height of each heating element depending on
an aimed temperature distribution to be formed on at
10 least one glass sheet, the aimed temperature distribution
can be more accurately formed. By adjusting the height
of each heating element depending on an aimed shape of at
least one glass sheet to be bended, a desired temperature
distribution can be formed on at least one glass sheet
15 having various shapes. Also in this example, the heater
rack 7 is supported separably from the ceiling inner wall
of the heating furnace in the same manner as in the
example of Figure 5.

Figure 7 is a structure view of an inner part of a
20 furnace illustrating an example of a bending apparatus of
the present invention.

As shown in this Figure, a ceiling heater 8 is
provided on the ceiling of a heating furnace 15 (bending
zone Z2 in Figure 1). Also, a conveyer 10 is provided
25 through each zone Z1, Z2 and Z3 in the heating furnace
(see Figure 1), and a bending mold 9 is conveyed. At
least one glass sheet (not shown) is placed on the

bending mold 9. A floor heater 3 is provided under the conveyer 10. In this manner, a first group of heating elements comprises the ceiling heater 8 and the floor heater 3. A radiation-heating device 2 (a second group of heating elements) is suspended in the vicinity above at least one glass sheet (not shown) on the bending mold 9. In this case, the ceiling heater 8 on the back side of the radiation-heating device 2 may be selectively used without using all of them.

Figure 8 is a structure view of an inner part of a furnace illustrating another example of a bending apparatus of the present invention. In this example, a radiation-heating device 2 comprising heating elements ① to ⑤ having various heights provided on a heater rack 7 is suspended from the ceiling of a furnace as a radiation-heating device in the same manner as in the example of Figure 6.

Figure 9 is a sectional view illustrating a preferable structure of a heating element.

A ceramic board 13 is provided on the lower side of a heater rack 7, and a heater wire 14 is embedded within the ceramic board 13. An equally heating plate 11 is fixed on the heater rack 7 by a supporting rod 12 so as to cover the lower side of the heater wire 14. By providing the equally heating plate 11, heat from the heater wire 14 makes a temperature within the equally heating plate equal, and a uniform radiation heat from

each heating element can be applied to at least one glass sheet, thereby enabling to control a temperature distribution at a high accuracy. In place of using such an equally heating plate 11, a heating element having a temperature-controlling heating face may be used to control a temperature of the heating surface.

INDUSTRIAL APPLICABILITY

As explained above, according to the present invention, at least one glass sheet can be satisfactorily bended by effectively using each heating element, i.e. by maintaining a satisfactory heat-bending temperature in the whole part in a heating furnace by a first group of heating elements fixed on an inner wall surface of the heating furnace and by efficiently heating the glass sheet by a second group of heating elements provided at a position close to the glass sheet but apart from the inner wall surface of the furnace.

Also, it is possible to efficiently form a desired temperature distribution on at least one glass sheet at a high accuracy by a simple structure having a heating device comprising a plurality of temperature-controlling heating elements provided close to the glass sheet so as to be capable of forming a temperature distribution on the glass sheet by radiation heat from each heating element. By this manner, a glass sheet to be bended can be efficiently heated in conformity with its shape, and the accuracy of bending can be raised and productivity

can be improved.

CLAIMS

1. A bending apparatus for bending at least one glass sheet placed on a bending mold into a desired shape by heating in a furnace, which comprises a bending mold for placing at least one glass sheet thereon, a tunnel-like heating furnace through which the bending mold is conveyed, a first group of a plurality of heating elements fixed on an inner wall of the heating furnace, and a radiation-heating device having a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.
2. The bending apparatus for at least one glass sheet according to Claim 1, wherein the second group of heating elements radiation-heat locally at least one glass sheet at a predetermined position to provide a predetermined temperature distribution on the glass sheet.
3. The bending apparatus for at least one glass sheet according to Claim 1 or 2, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.
4. The bending apparatus for at least one glass sheet according to Claim 1, 2 or 3, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.
5. The bending apparatus for at least one glass sheet according to Claim 1, 2, 3 or 4, wherein each heating

element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

6. A method of bending at least one glass sheet into a
5 desired shape, which comprises placing at least one glass sheet on a bending mold, introducing the glass sheet placed on the bending mold into a heating furnace having a tunnel-shaped inside, and heating the glass sheet by two types of heating means of a first group of a
10 plurality of heating elements fixed on an inner wall surface of the heating furnace and a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

7. The method of bending at least one glass sheet
15 according to Claim 6, wherein the second group of heating elements radiation-heat locally at least one glass sheet to provide a predetermined temperature distribution on the glass sheet.

8. The method of bending at least one glass sheet
20 according to Claim 6 or 7, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass
25 sheet.

9. The method of bending at least one glass sheet according to Claim 6, 7 or 8, wherein a distance between

the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

- 5 10. The method of bending at least one glass sheet according to Claim 6, 7, 8 or 9, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

INTERNATIONAL SEARCH REPORT

 International Application No.
 PCT/JP 00/06518

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C03B29/08 C03B23/023 C03B23/025

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 443 948 A (SAINT-GOBAIN VITRAGE INTERNATIONAL) 28 August 1991 (1991-08-28) the whole document ---	1-10
X	EP 0 928 779 A (ASAHI GLASS COMPANY LTD.) 14 July 1999 (1999-07-14) the whole document ---	1-10
X	EP 0 659 697 A (PILKINGTON GLASS LIMITED) 28 June 1995 (1995-06-28) the whole document ---	1-10
X	EP 0 592 862 A (TAMGLASS ENGINEERING OY) 20 April 1994 (1994-04-20) the whole document ---	1-10
	--- -/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

4 January 2001

Date of mailing of the international search report

10/01/2001

Name and mailing address of the ISA

 European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
 Fax: (+31-70) 340-3016

Authorized officer

Van den Bossche, W

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/JP 00/06518

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 486 952 A (TAMGLASS OY) 27 May 1992 (1992-05-27) the whole document ---	1-10
X	EP 0 443 947 A (SAINT-GOBAIN VITRAGE INTERNATIONAL) 28 August 1991 (1991-08-28) the whole document ---	1-10
X	EP 0 058 529 A (MCMASTER) 25 August 1982 (1982-08-25) the whole document ---	1-10
X	DE 21 58 812 A (SAINT-GOBAIN) 15 June 1972 (1972-06-15) the whole document -----	1-10

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/JP 00/06518

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 443948 A	28-08-1991	FR 2658808 A	30-08-1991
		BR 9100667 A	29-10-1991
		CA 2036459 A	22-08-1991
		CS 9100449 A	15-10-1991
		DE 69104085 D	27-10-1994
		DE 69104085 T	13-04-1995
		ES 2063458 T	01-01-1995
		FI 94126 B	13-04-1995
		FI 910829 A,C	22-08-1991
		HU 215817 B	01-02-1999
		JP 5116972 A	14-05-1993
		KR 214109 B	02-08-1999
		PT 96826 A,B	29-01-1993
		US 5173102 A	22-12-1992
EP 928779 A	14-07-1999	JP 10279323 A	20-10-1998
		JP 10279324 A	20-10-1998
		BR 9804808 A	17-08-1999
		CZ 9803948 A	16-06-1999
		WO 9845214 A	15-10-1998
EP 659697 A	28-06-1995	AT 192422 T	15-05-2000
		AU 686682 B	12-02-1998
		AU 8047994 A	29-06-1995
		BR 9405196 A	01-08-1995
		CA 2138620 A	24-06-1995
		CN 1121052 A	24-04-1996
		DE 69424266 D	08-06-2000
		FI 946087 A	24-06-1995
		JP 7277754 A	24-10-1995
		NZ 270138 A	28-10-1996
		PL 306396 A	26-06-1995
		RO 111359 B	30-09-1996
		RU 2137723 C	20-09-1999
		TR 28068 A	02-01-1996
		US 5656052 A	12-08-1997
		ZA 9410291 A	23-06-1995
EP 592862 A	20-04-1994	FI 91521 B	31-03-1994
		FI 932861 A	22-12-1994
		FI 933318 A,B,	22-12-1994
		AT 149978 T	15-03-1997
		AU 666043 B	25-01-1996
		AU 4879593 A	28-04-1994
		CA 2107841 A	16-04-1994
		CN 1088550 A,B	29-06-1994
		DE 69308715 D	17-04-1997
		DE 69308715 T	19-06-1997
		JP 7300328 A	14-11-1995
		US 5437704 A	01-08-1995
		US 5472469 A	05-12-1995
		FI 935664 A,B,	22-12-1994
EP 486952 A	27-05-1992	FI 905695 A	15-05-1992
		US 5470367 A	28-11-1995
		DE 69113953 D	23-11-1995
		DE 69113953 T	11-04-1996
		JP 4275928 A	01-10-1992

INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP 00/06518

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 443947 A	28-08-1991	FR 2658499 A	23-08-1991
		CA 2036460 A	22-08-1991
		DE 69105297 D	12-01-1995
		DE 69105297 T	22-06-1995
		ES 2066377 T	01-03-1995
		FI 93719 B	15-02-1995
		FI 910828 A,C	22-08-1991
		JP 4243927 A	01-09-1992
		KR 214110 B	02-08-1999
		PT 96825 A,B	29-01-1993
		US 6092393 A	25-07-2000
		US 5122180 A	16-06-1992
EP 58529 A	25-08-1982	US 4505671 A	19-03-1985
		AU 547475 B	24-10-1985
		AU 8012982 A	26-08-1982
		BR 8200703 A	14-12-1982
		CA 1190747 A	23-07-1985
		EG 15071 A	31-12-1985
		ES 509623 D	01-06-1983
		ES 8306686 A	16-09-1983
		FI 820508 A	18-08-1982
		IE 53098 B	22-06-1988
		IN 156495 A	17-08-1985
		JP 1384262 C	26-06-1987
		JP 57166327 A	13-10-1982
		JP 61054731 B	25-11-1986
		MX 157067 A	25-10-1988
		ZA 8200692 A	26-01-1983
		US 4529380 A	16-07-1985
DE 2158812 A	15-06-1972	FR 2139605 A	12-01-1973
		AT 318164 B	25-09-1974
		BE 776175 A	02-06-1972
		CA 959265 A	17-12-1974
		CH 541787 A	15-09-1973
		ES 397610 A	16-06-1974
		FI 52964 B	30-09-1977
		GB 1322097 A	04-07-1973
		IT 953136 B	10-08-1973
		JP 52042812 B	26-10-1977
		LU 64395 A	23-08-1972
		NO 130061 B	01-07-1974
		SE 376650 B	02-06-1975
		ZA 7108026 A	30-08-1972